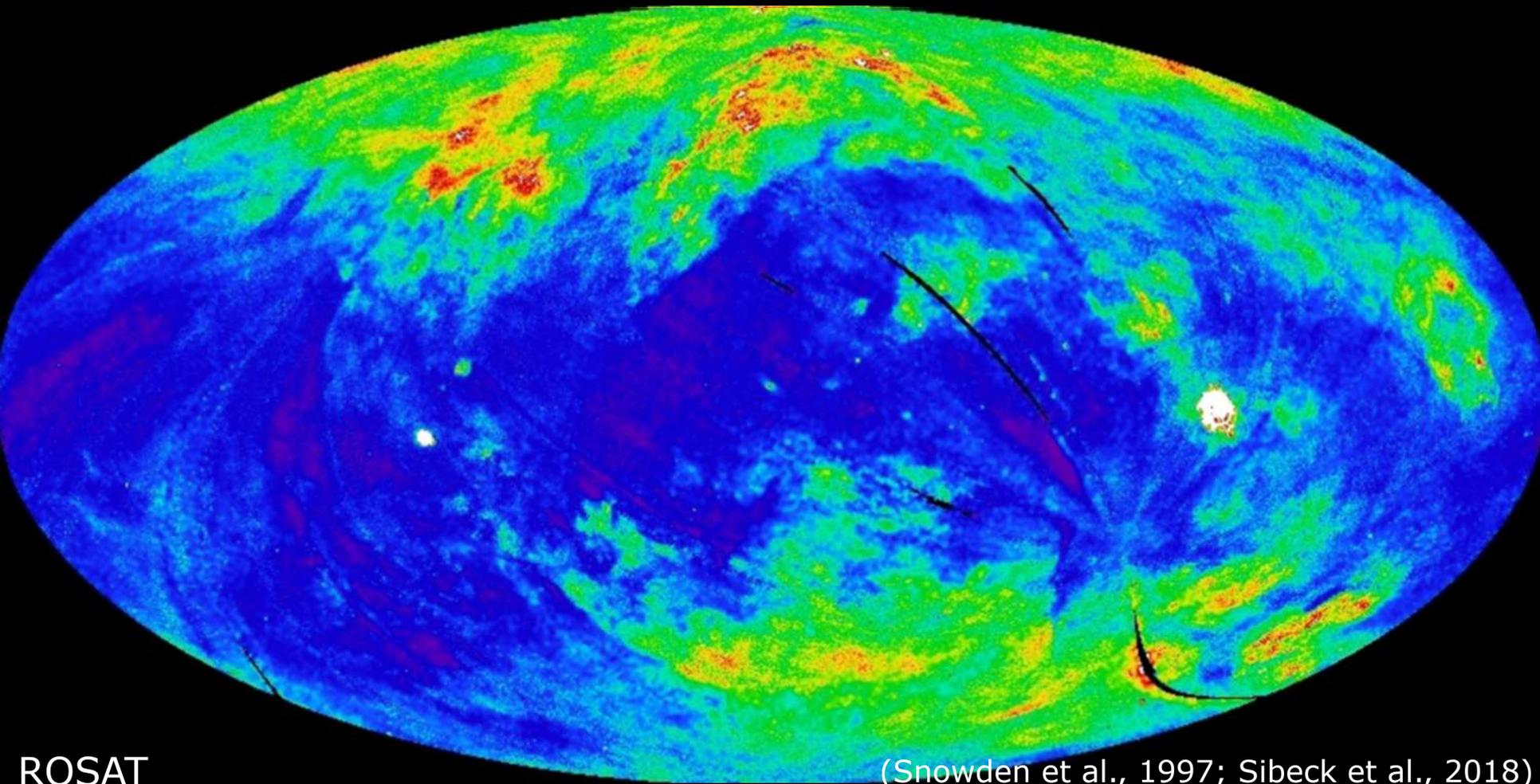


# SMILE new imaging magnetospheric mission and collaboration with Swarm

C. Philippe Escoubet (ESA, ESTEC), G. Branduardi-Raymont (MSSL, UK), Chi Wang (NSSC, China) and C. Forsyth (MSSL, UK)

# X-ray Long Term Enhancements



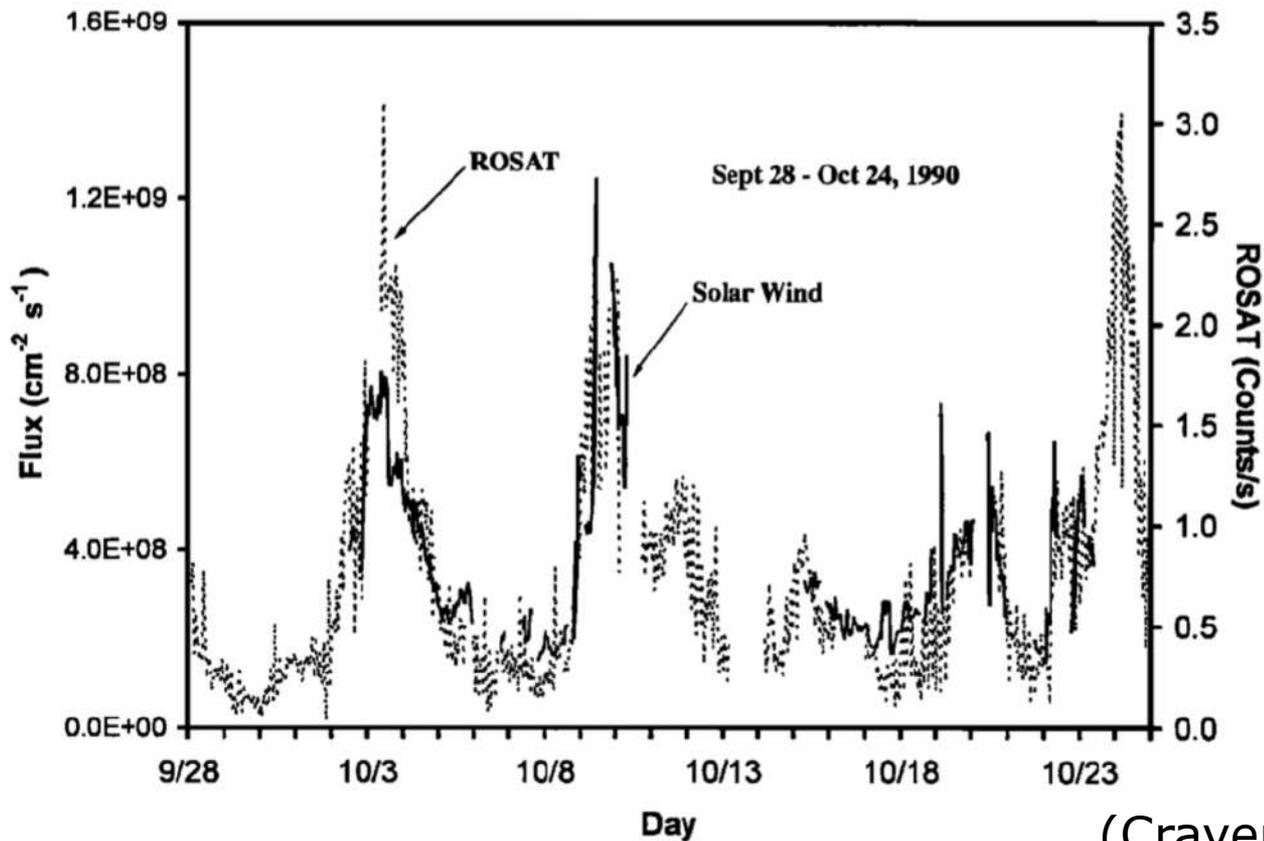
ROSAT

(Snowden et al., 1997; Sibeck et al., 2018)

# Solar wind charge exchange at Earth

CAS

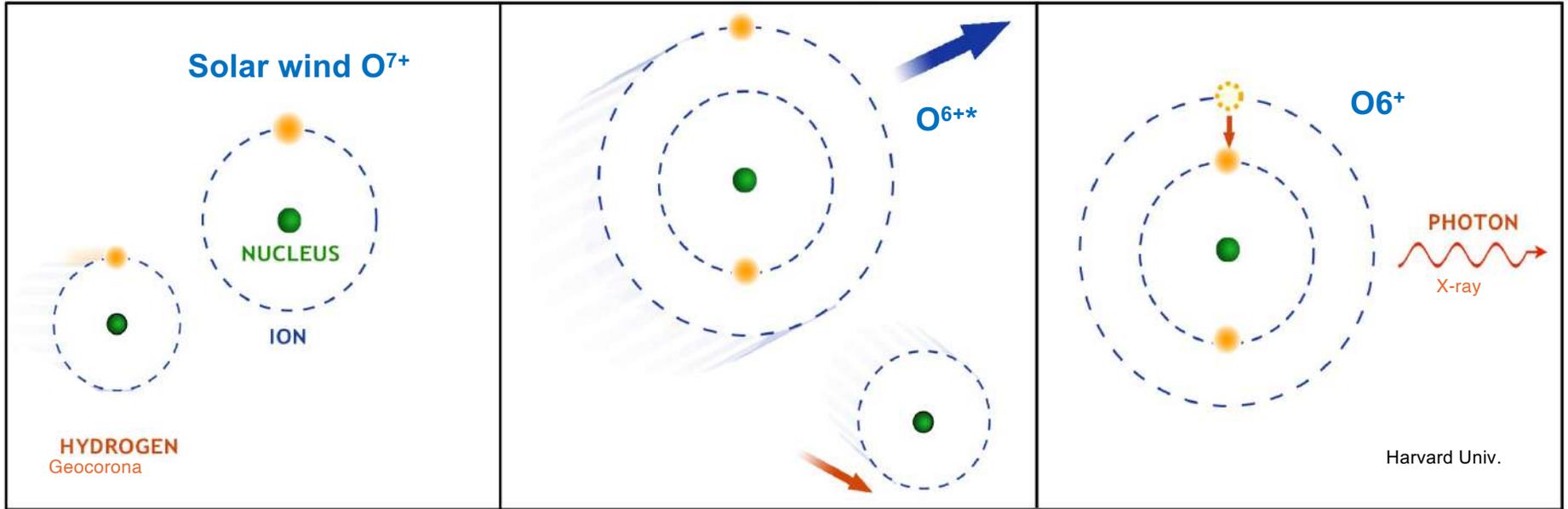
Solar  
wind  
flux



LTE

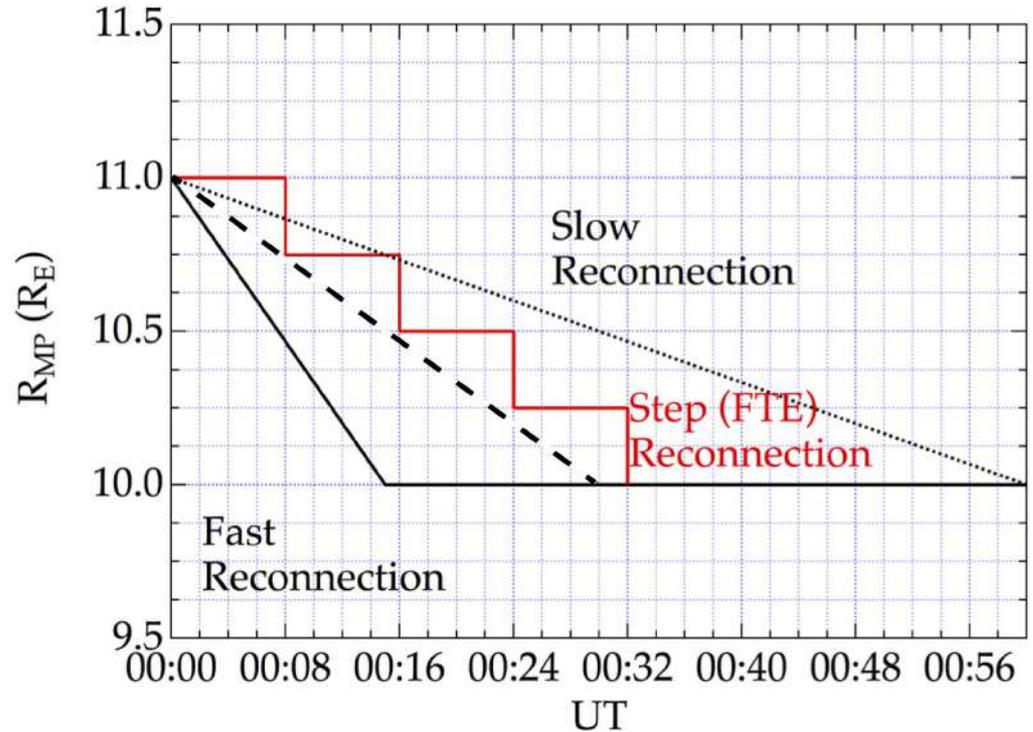
(Cravens et al., 2001)

# Solar wind charge exchange process



# 1. What are the fundamental modes of the solar wind/magnetosphere interaction?

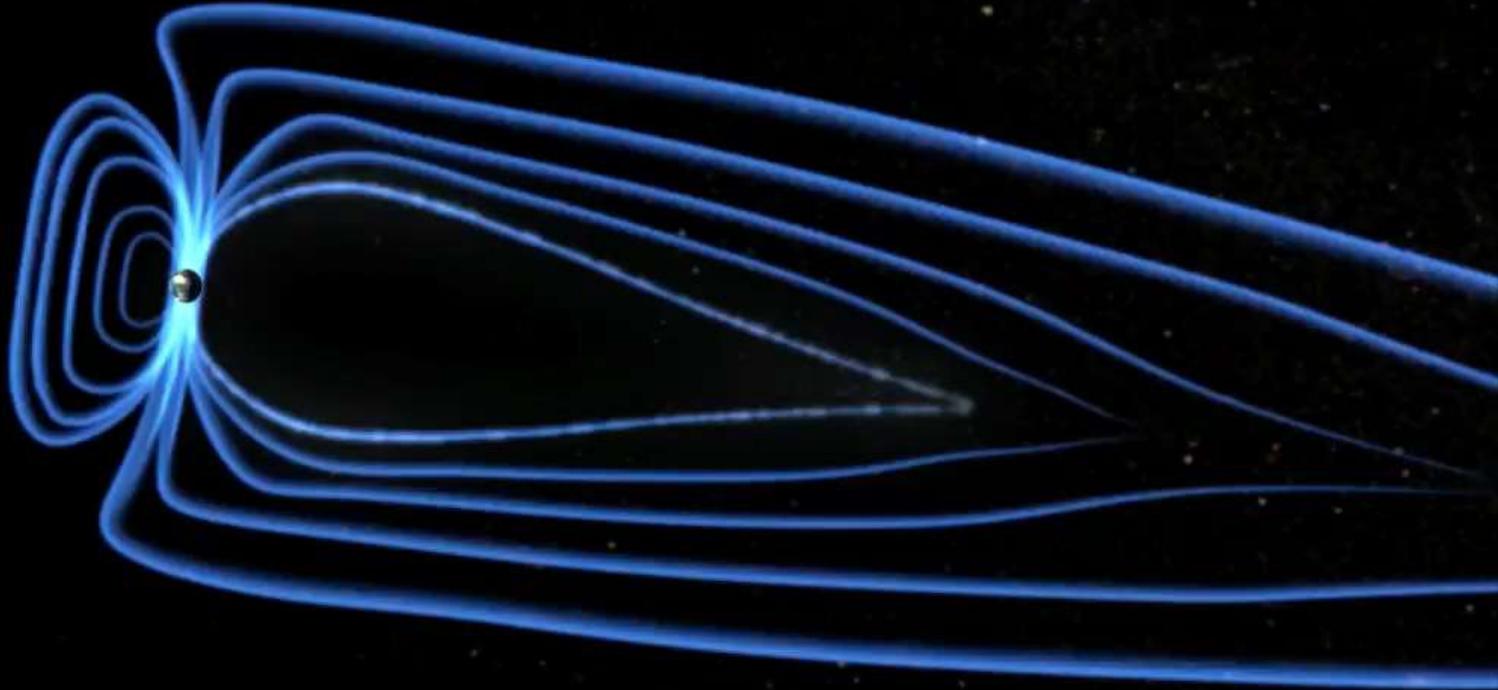
- When/where is **reconnection** steady/transient/bursty, patchy or global?
- Dependent on solar wind parameters or intrinsic instabilities?
- Role of the magnetospheric cusps in solar wind/magnetosphere coupling



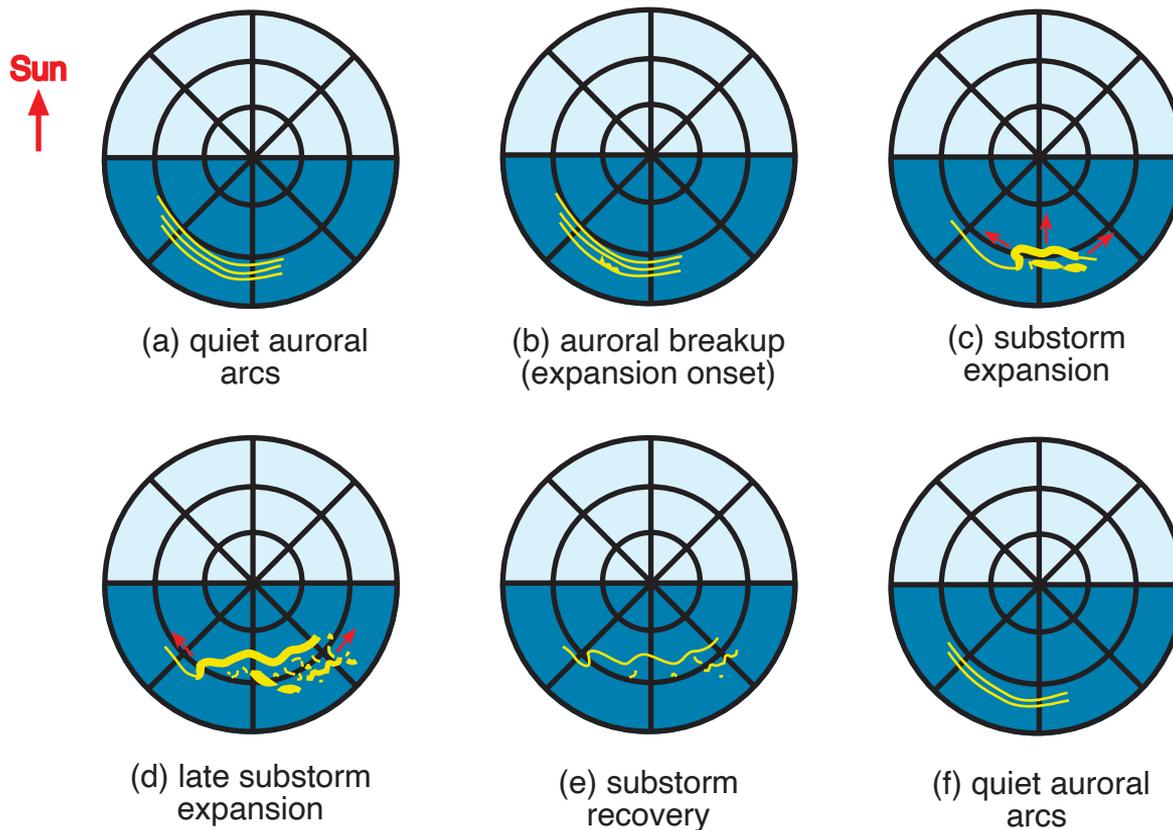
(Sibeck et al., 2023)

SMILE will measure the position of magnetopause and cusp

## 2. What defines the substorm cycle?

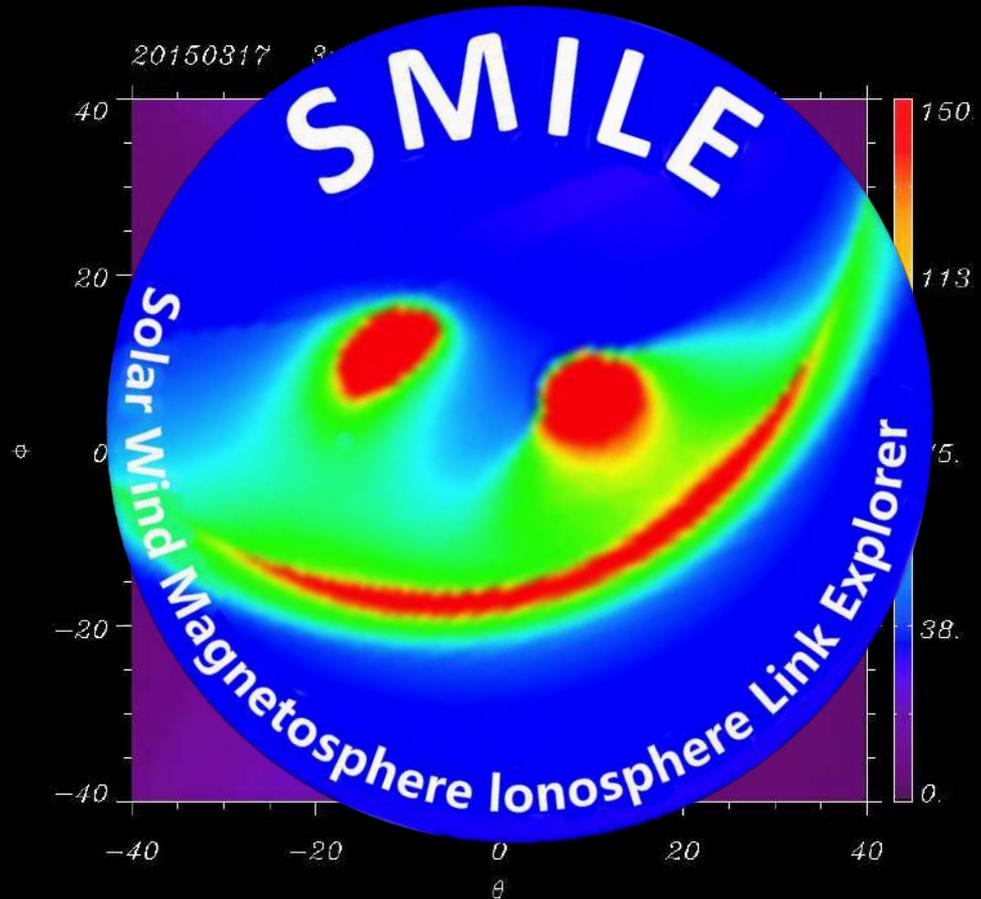
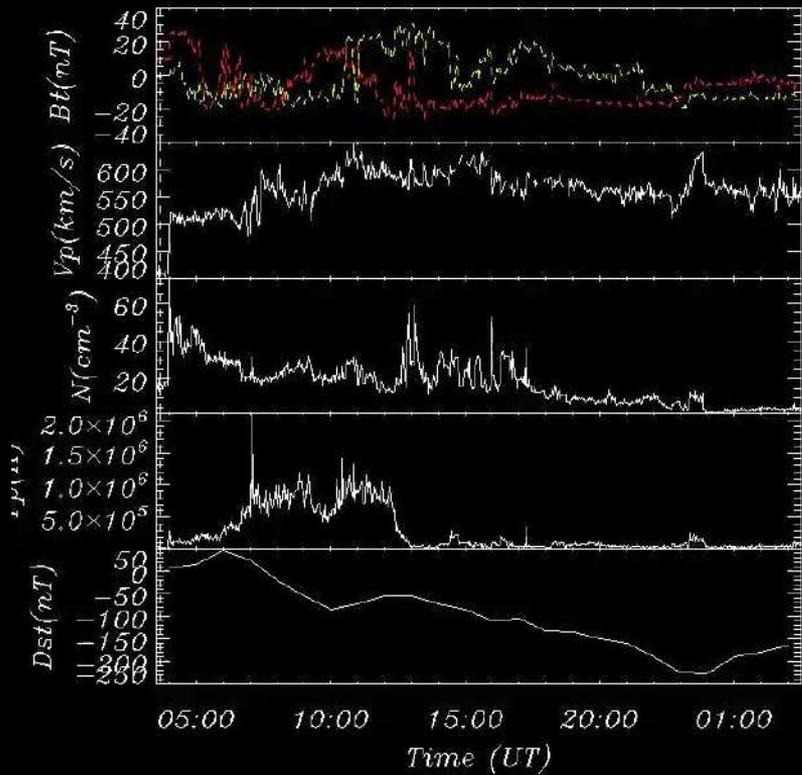


## 2. What defines the substorm cycle?



(A. Lui, private communication)

### 3. How do CME-driven storms arise and what is their relationship to substorms?



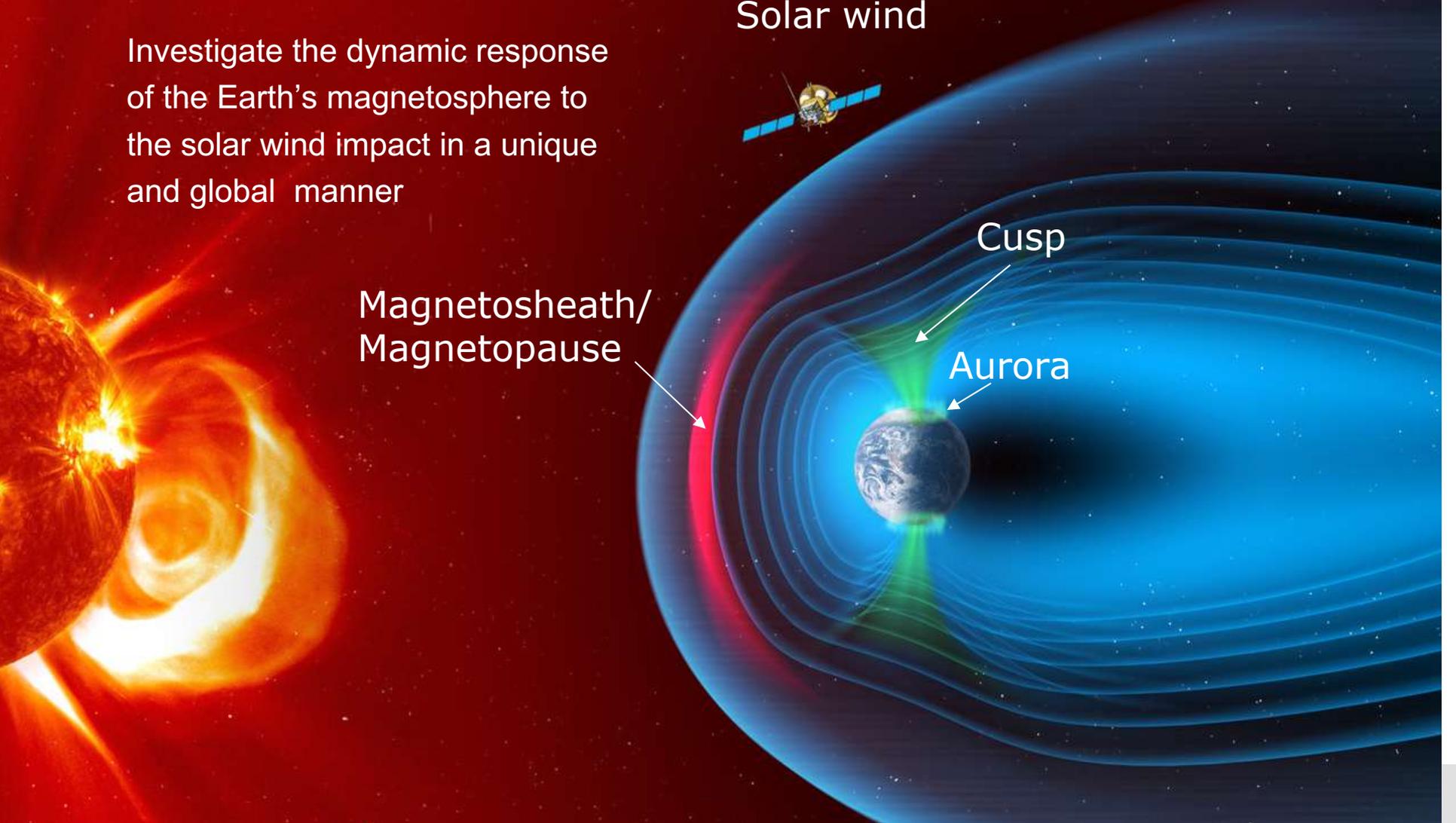
Investigate the dynamic response of the Earth's magnetosphere to the solar wind impact in a unique and global manner

Solar wind

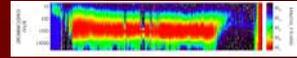
Magnetosheath/  
Magnetopause

Cusp

Aurora



Investigate the dynamic response of the Earth's magnetosphere to the solar wind impact in a unique and global manner



ions



magnetic field

Soft X-ray  
 $15 \times 10^{26}$

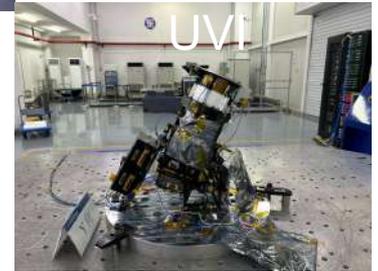
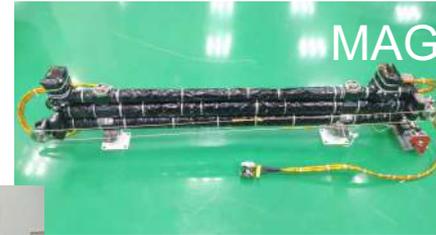
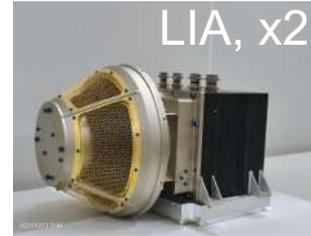
Auroral oval UVI  
 $10 \times 10^9$

## Science questions

- What are the fundamental modes of the dayside solar wind/magnetosphere interaction?
- What defines the substorm cycle?
- How do CME-driven storms arise and what is their relationship to substorms?

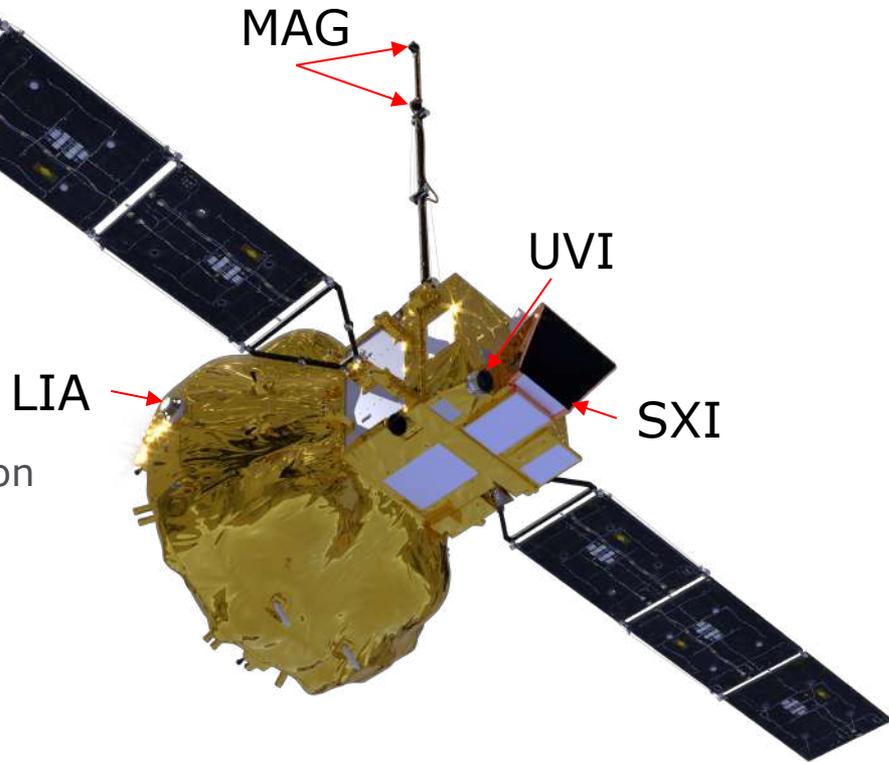
# SMILE INSTRUMENTS

1. LIA (Light Ion Analyser) is a top-hat analyser for detection of ions. Energy range 5 eV-20 keV, 4 π FOV at up to 0.25s resolution. **PI: Lei DAI, NSSC, CAS, China**
2. MAG (Magnetometer) is a flux-gate magnetometer with two sensors on a 3m boom. **B** measured up to 40 Hz. **PI: Lei LI, NSSC, CAS, China**
3. SXI is a wide field lobster-eye 0.2-5 keV X-ray imager. CCD detectors. 16 x 27 degree FOV. Resolution: 1-5 min., 0.25-1°. **PI: Steve Sembay, Leicester, UK**
4. UVI (UV imager) is a four mirror imager in the range 155-175 nm, 10° FOV. Resolution 60 s, 150 km. **PI: Xiaoxin ZHANG, NCSW, CMA, China**



# SMILE spacecraft

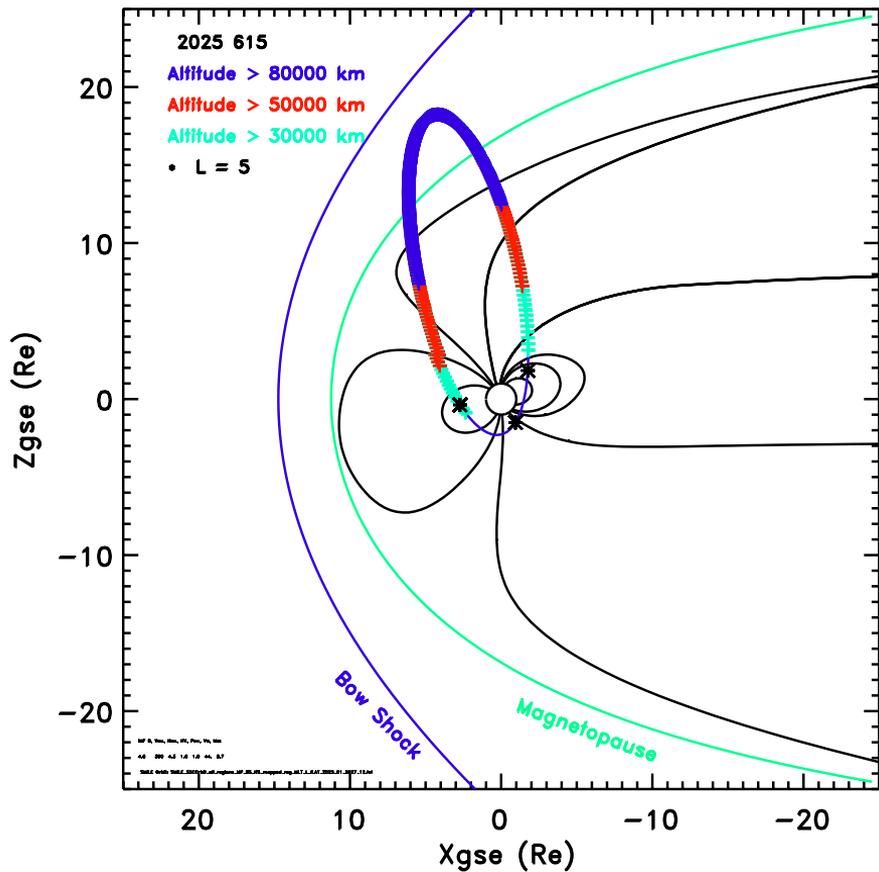
- 3-axis stabilised
- Mass (with propellant): 2200 kg
- Dimensions in orbit: 4.7 m × 9.8 m × 3.5 m
- S-band and X-band
- Telemetry rate: 36 Gbit/orbit downlink
- Baseline orbit: 1 x 20 Earth radii, 70° inclination
- Launch: 2025 with Vega C



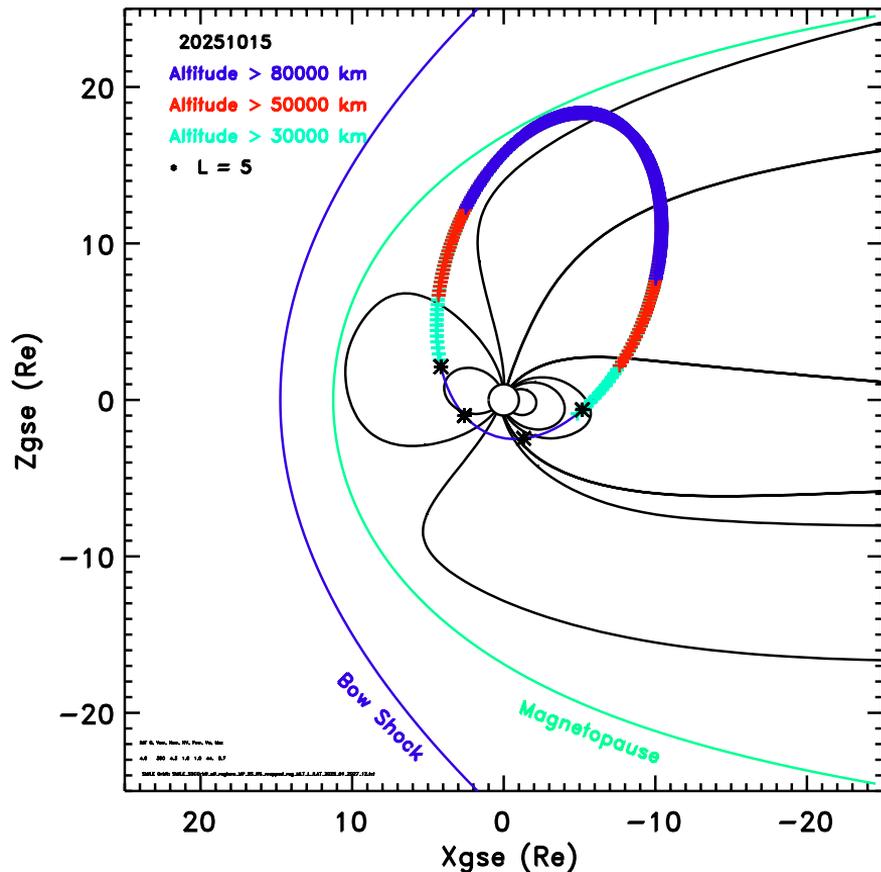
# SMILE orbit: 5000 x 120000 km, ~50 h period



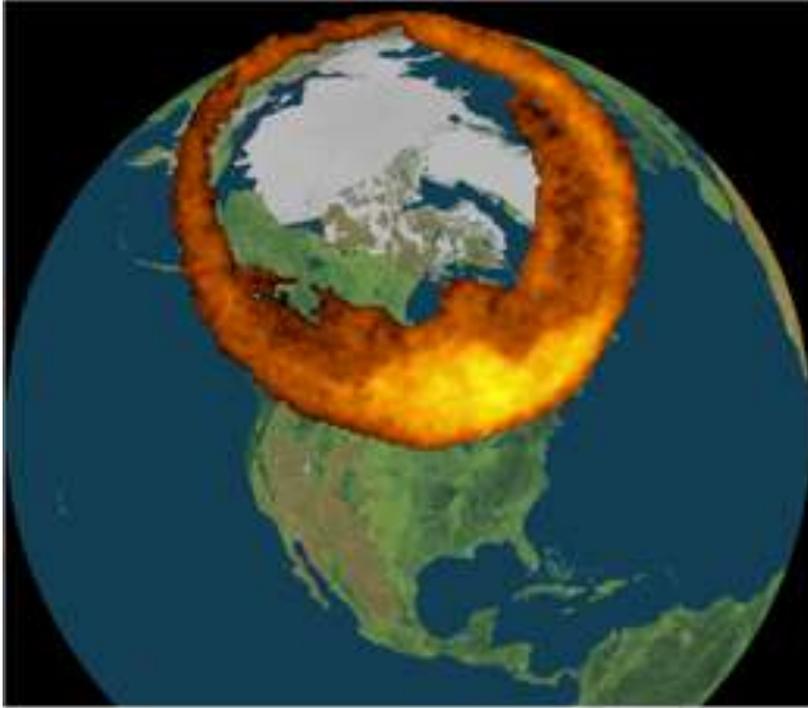
## Summer



## Fall

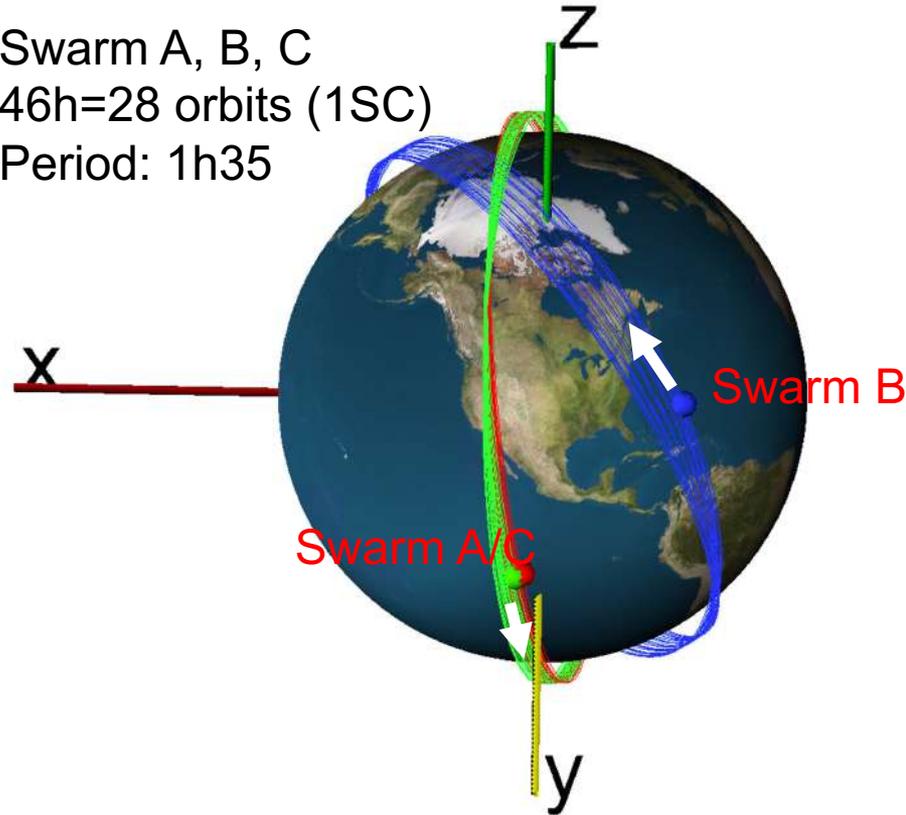


# Auroral oval boundaries with SMILE and Swarm



L. Franc, NASA Polar image

Swarm A, B, C  
46h=28 orbits (1SC)  
Period: 1h35



# SMILE and Swarm complementarity

- Magnetopause/cusp position and motion (SMILE science goal):
  - SMILE will obtain the magnetopause position and motion with SXI (up to 40h continuous every 51h)
  - Swarm will measure the position and motion of Open Closed Boundary (Cusp equatorward boundary) (TBC) (May be dependent on time of the year)
  - Within 40h of SMILE observations, Swarm will cross the polar cusp OCB (25 times x 2 hemis. x3 sat= 150 times)
- Determination of the poleward and equatorward boundary of the auroral oval (SMILE science goal):
  - SMILE will image the auroral oval (up to 46h continuous every 51h)
  - Swarm could measure the position and motion of auroral oval (equatorward and poleward boundaries)
  - Within 46h of SMILE observations, Swarm will cross the auroral oval (28 times x2 D&N x3 sat= 168 times)
- Observation of auroral oval brightening during substorms (SMILE science goal) :
  - SMILE will measure transient brightening and their evolution
  - Swarm (if located at right local time) will observe the strong currents producing the brightening and their motion

- It will image the auroral oval for more than 45h continuously per orbit
- It will observe the magnetopause, cusp and magnetosheath for the first time in soft X-rays
- It will measure the solar wind and magnetosheath plasma simultaneously to imaging.
- Cooperation with China with equal share, building on Double Star experience
- SMILE mission will be launched in 2025
- Highly complementary with Swarm (polar regions simultaneous measurements)

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